Wildlife and Fish Health Effects in Canadian AOCs

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Great Lakes Areas of Concern

- In 1987, the International Joint Commission designated 43 areas of concern in the Great Lakes Basin
- To qualify as an AOC, the area contained one or more beneficial use impairment

Beneficial Use Impairments

- restrictions on fish and wildlife consumption
- tainting of fish and wildlife flavor
- degradation of fish and wildlife populations
- fish tumors or other deformities
- bird or animal deformities or reproduction problems
- degradation of benthos
- restrictions on dredging activities
- eutrophication or undesirable algae
- drinking water restrictions, or taste and odor problems
- beach closings
- degradation of aesthetics
- added costs to agriculture or industry
- degradation of phytoplankton and zooplankton
- loss of fish and wildlife habitat

Areas of Concern in the Great Lakes - St. Lawrence River Basin

Past Effects

Reproductive Impairment In Fish-Eating Predators

- In the 1960s, Great Lakes fish were implicated in a large number of diet-related reproductive failures in ranch mink
- LOEL for mink kit survival associated with maternal liver PCBs=2.2 mg/kg
- Congenital malformations/GLEMEDs in fish-eating birds was associated with exposure to persistent organic contaminants such as dioxins and PCBs
- Reproduction in shore-line nesting eagles and cormorants failed
- Egg-shell thinning and hatching failures associated with DDT/DDE

Developmental abnormalities found in 9 species of fish-eating birds and in hatchling snapping turtles

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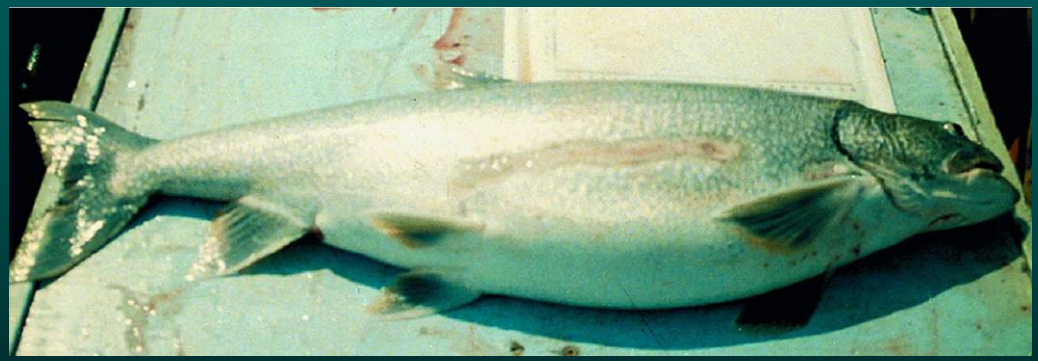
A combination of factors led to the decline of lake trout such that by 1960 they were extirpated from the Great Lakes; sea lamprey, overexploitation, changes in forage base, pollution

From mid 50's to mid 70's, Blue-Sac from exposure to TCDD-like contaminants was sufficient account for 100% offspring mortality in Lake Ontario (Cook et al. 2003)



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Effects of POPs on wildlife have been recognized and there has been action taken to reduce exposure

Good NEWS!!!

No Blue-Sac, Return of Fish-Eating Bird Populations

Concerns Leading to Recent Studies

- Health Canada Reports released in 2000 suggest some human health outcomes were more prevalent in certain AOCs
- What, if any, are the present Wildlife and Fish Health Effects in AOCs?
  - Last assessment summarizing known spatial and temporal trends in environmental contaminants and associated effects in fish & wildlife in 1991 "Toxic Chemicals in the Great Lakes and Associated Effects"

Fish and Wildlife Health Effects and Exposure Study

Objectives

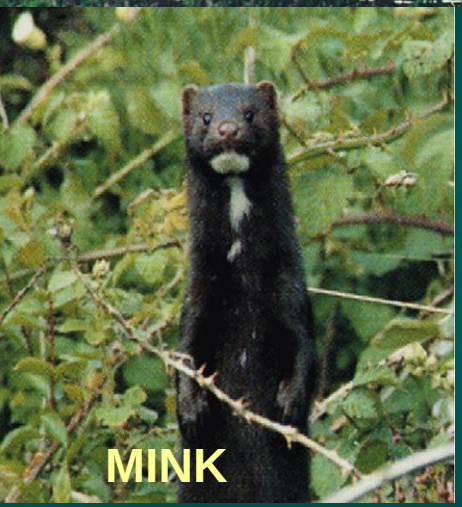
- Update understanding of the state of fish and wildlife health
- Determine if effects are similar to those in human population
- Measure current concentrations of chemicals (old and new) in aquatic environment and tissues that could be associated with heath outcomes

Phase I (2001-2005)

- Canadian AOCs in the lower Great Lakes
- Benthic and pelagic fish, Snapping Turtles, Herring Gulls and mink

Wildlife Assessments


HERRING GULL


MINK


SNAPPING TURTLE

- Laboratory analyses:
  - histology
  - enzyme activity
  - estrogenicity assays
  - immunotoxicity
  - hormone function
- Field assessments:
  - sex ratios
  - embryonic viability

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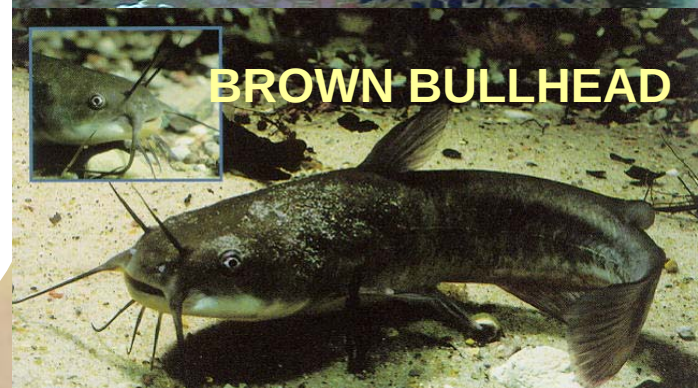
Assessment of Effects in Wild Fish

- Examination of gonad development, egg size, fecundity, expression of secondary sexual characteristics
- Measurement of circulating Vg, reproductive steroid hormone levels and thyroid hormones
- Determination of steroid and thyroid biosynthetic capacity
- Liver mixed-function oxidase (index of exposure to dioxin-like organochlorines)
- Histology of endocrine and other tissues (gonads, thyroid, liver, gills)
- Deformities and other anomalies



External Abnormalities in Brown Bullheads

Stubbed Barbels

Melanoma

Focal Discoloration

Surface lumps and bumps in Western Lake Erie are more prevalent 2001 than in 1990.

Association between sediment contaminants (e.g. PAHs & metals) and higher incidence of external abnormalities – particularly barbel and raised growths.

Raised Growth - Lip

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Stephen Smith, USGS

Health Changes Are Detectable!

- SNTUs, HERGs, Mink, Fish;
- subtle effects on thyroid, reproduction, physiology, morphology;
- all age stages, from embryos to young to adults;
- likely not just a OC issue, effects suggest impacts from other contaminants like EDSs
- effects mostly found at sites nearest to the AOCs.

What has wildlife told us about the current Great Lakes environment?

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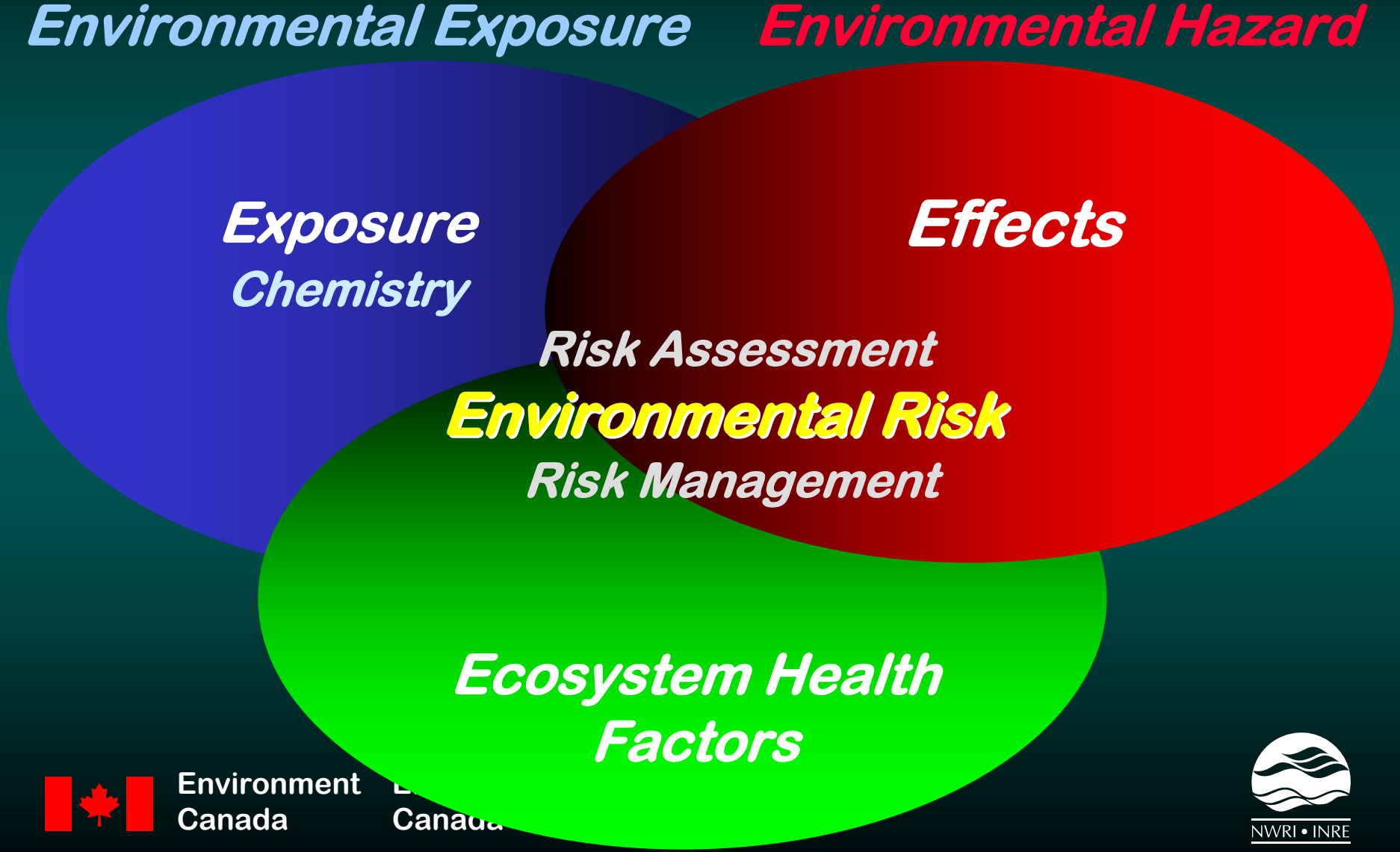
Assessment of Effects



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Ecosystem Health Factors

- Alien species have appeared at the rate of one per year since Dreissena invasion, “controls” not working.

- Assessment of effects of alien species impeded by lack of basic annual data on distribution and numbers.

Overview of Great Lakes Salmonids Today

- With exception of Lake Superior and parts of Lake Huron still recruitment bottleneck for lake trout
- Early mortality syndrome in salmonids
- Major prey species for salmonids
  - alewife, rainbow smelt, and bloater chub
- Thiamine deficiency is a major factor
- Alien invasive species contain thiamine degrading activity
  - alewife and rainbow smelt

What is Early Mortality Syndrome (EMS)?

Observed between hatch and first feeding in Great Lakes salmonids and is characterized by:

- **Loss of equilibrium**
- **Swimming in a spiral pattern**
- **Lethargy**
- **Hyperexcitability**
- **Hemorrhage, etc.**

} ***Neurological Symptoms***

Healthy

EMS

"It seems to me that no better case for ecosystem disruption can be made than its predatory inhabitants are suffering varying degrees of beriberi"

--- Rod Horner, Illinois DNR

EMS is a symptom of a degraded ecosystem and it's presence emphasizes the need for maintaining biodiversity

Photo by Chad Boyko

Great Lakes Food Web Effects

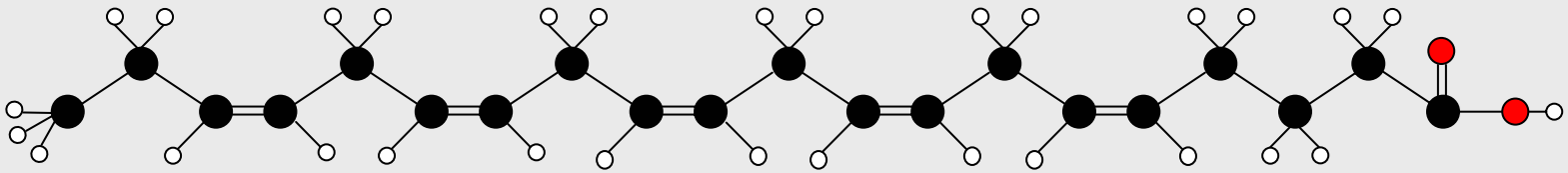
"Nearshore Shunt"

Harvesting of offshore waters by mussel filtration nearshore may alter food web, affect YOY fish survival, increase/decrease export of nutrients and contaminants.

Food Quality Issues (nutrition)

- **Need to assess impacts of dreissenids and *Bythotrephes* on production at higher trophic levels.**
- **Since the mid 1990's *Diporeia*, normally about 70 % of the biomass on the bottom, has disappeared in parts of the Great Lakes, except Superior, including all suitable habitat in Lake Erie, and above 80 m depth in Lake Ontario, Lake Michigan and southern Lake Huron.**
- **Need to examine the flow of essential nutrients from the base of the food web to key species.**
- **Gizzard shad and gobies now major components.**

20:5n-3 = EPA (Ecosapentaenoic acid)



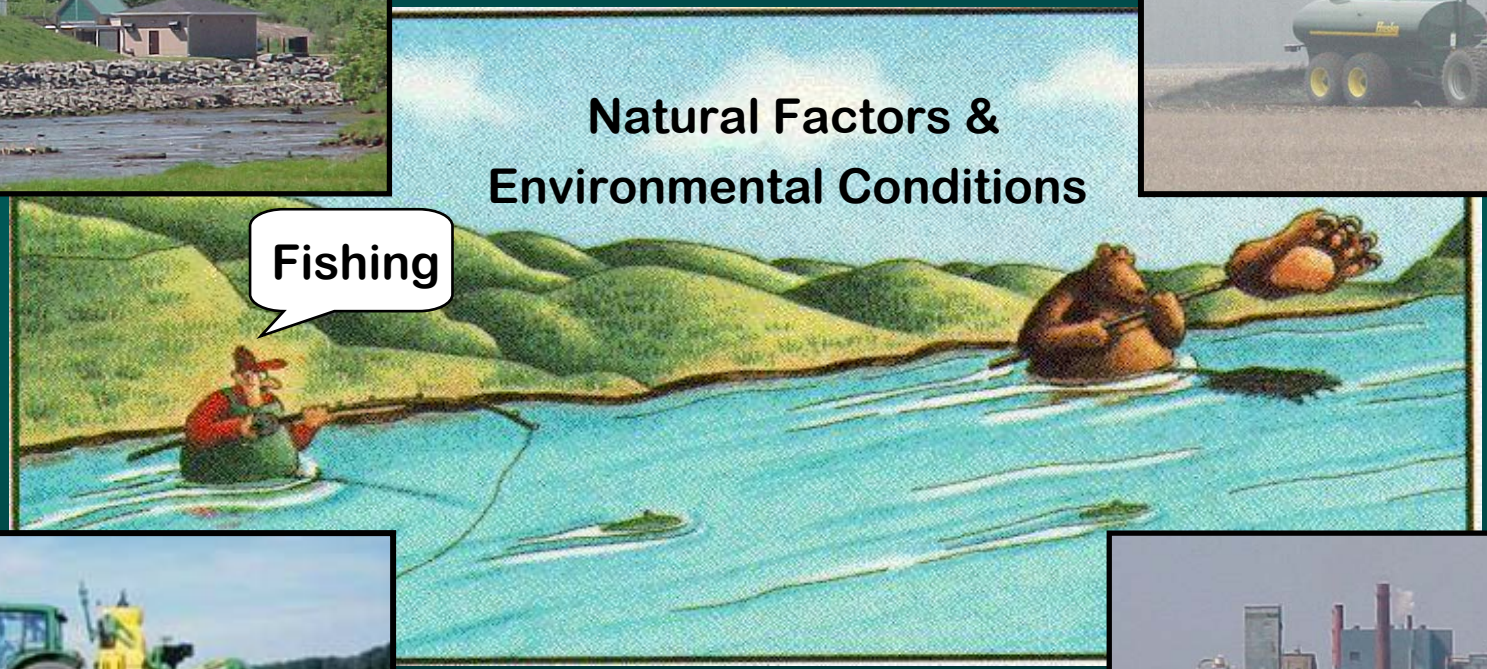
Other Effects

- Shoreline filamentous algae - research largely dropped but problem has re-occurred.
- Sporadic blue-green algae blooms sporadic – taste/odor compounds and toxins produced.
- Botulism outbreak: why now? linkage with gobies, blue-green algae toxins?

There are Many Potential Causes for Declines in Wildlife and Fish Populations

Sewage

Farm Wastes



Ag-chemicals in runoff

Industry